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Proposed Comprehensive Monitoring, Assessment, and Research Program for Water Quality in the San Joaquin Basin

Charlie Kratzer, USGS; Manucher Alemi, DWR-SJVDIP; Earle Cummings, DWR-ESO; Les Grober, CVRWQCB; Marshall Lee, DPR; Mike Zanoli, DWR-MWQI

1. Introduction

For the purposes of CMARP we are defining the San Joaquin Basin (SJB) as it is defined in the CALFED Water Quality Program Plan (WQPP) (Programmatic EIS/R, Technical Appendix, March 1998). The SJB includes the drainage of the San Joaquin, Calaveras, Mokelumne, and Cosumnes rivers. Unlike the WQPP, we are not including the Tulare Lake Basin in this document since it has only a minor impact on water quality in the SJB. The scope of this document is all aspects of water quality in the SJB, including biological, chemical, and physical aspects of the water column, bioassessments, toxicity, and sediment quality.

2. Monitoring Objectives

The monitoring objectives applicable to water quality in the SJB discussed in this document include: (1) a monitoring network to evaluate the success of proposed CALFED WQPP actions, (2) a monitoring network to address (or verify) identified water quality problems in the SJB based on the 303(d) list of impaired water bodies, and (3) a monitoring network to assess trends, loads, and sources of water quality constituents. The proposed monitoring plan will make use of existing agency monitoring programs as much as possible.

The proposed WQPP actions specifically addressed by this monitoring plan are:

- Reduce the impairment of environmental and recreational beneficial uses within the Delta, Sacramento, and San Joaquin River regions associated with mercury loadings by source control and/or treatment of mine drainage at inactive and abandoned mine sites.
- Reduce the impairment of environmental beneficial uses in the Delta, Sacramento, and San Joaquin River regions associated with copper, zinc, and cadmium from urban and industrial runoff.

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- Reduce (or eliminate) the impairment of environmental beneficial uses in the Delta, Sacramento, and San Joaquin River Regions associated with the urban, industrial, and residential pesticides chlorpyrifos and diazinon through source control of urban and industrial runoff.
- Reduce the impairment of environmental and recreational beneficial uses within the Delta Region (specifically near Stockton) due to oxygen-depleting substances (nutrient loadings) through source control of urban and industrial runoff.
- Evaluate the loadings of TOC, salinity, and pathogens in urban runoff and assess the need for source control measures to reduce these parameters of concern to drinking water beneficial uses.
- Reduce the impairment of environmental and recreational beneficial uses due to oxygen depleting substances within the Delta Region (specifically the lower San Joaquin River) through cost effective source control and treatment of industrial and municipal wastewater discharges.
- Reduce the impairment of environmental beneficial uses in the Delta Region and its tributaries associated with ammonia from wastewater treatment plant discharges through improved treatment. This action is focused on wastewater treatment plant discharges to water bodies with minimum "dilution" flows.
- Evaluate the loadings of TOC, salinity, and pathogens from wastewater and industrial treatment plant discharges, and assess the need for source control measures to reduce these parameters of concern to drinking water beneficial uses.
- Reduce the impairment of environmental beneficial uses to the lower San Joaquin River and Delta regions associated with selenium loadings by controlling sources of selenium in agricultural subsurface drainage.
- Reduce salinity impairment of drinking water and agricultural beneficial uses to Delta Region associated with salinity through source control and treatment of agricultural surface and subsurface drainage in the San Joaquin River Region.
- Reduce the impairment of environmental uses in the Delta Region associated with the pesticides carbofuran, chlorpyrifos, and diazinon through incentives.
- Reduce the impairment of environmental and drinking water beneficial uses in the Delta Region and its tributaries associated with sediment loading through incentives.
- Reduce the impairment of environmental and recreational beneficial uses in the Delta Region and its tributaries associated with nutrients and ammonia through source control of agricultural surface drainage.
- Reduce the impairment of drinking water beneficial uses within the Delta Region associated with pathogens by controlling inputs from rangeland, dairies, and confined animal facilities.
- Reduce impairment of drinking water beneficial uses in the Delta Region associated with TOC, pathogens, turbidity, and bromides by reducing levels of these substances at domestic water supply intakes.
- Reduce the impairment of environmental, agricultural, and drinking water beneficial uses associated with salinity using water management techniques.

- Reduce impairment of agricultural beneficial uses in the South Delta associated with salinity through improved outflow patterns and water circulation in the Delta Region.
- Reduce impairment of recreational beneficial uses within the Delta Region due to human health concerns associated with consumption of fish and shellfish containing elevated levels of DDT, chlordane, toxaphene, mercury, and PCBs and their derivatives.
- Identify parameters of concern in the water and sediment within the Delta, Bay, Sacramento River, and San Joaquin River regions and implement actions to reduce their toxicity to aquatic organisms.

The SWRCB/RWQCB updated their 303(d) list of impaired water bodies in the SJB in 1998. The revised list is shown in table 1. The water bodies on this list will be given highest priority in the monitoring plan developed here.

[Table 1. Impaired water bodies in SJB – 303(d) list]

3. Conceptual Model of the San Joaquin Basin

Our conceptual model of water quality in the SJB results from several major water quality studies of the basin over the past 15 years including: (1) DWR Drainage Monitoring Program, (2) San Joaquin Valley Drainage Program, (3) SWRCB/RWQCB SJR Technical Committee, (4) Grasslands Bypass Project, (5) DPR/RWQCB dormant spray studies, and (6) USGS' San Joaquin-Tulare Basins NAWQA. In general, non-point sources of pollutants dominate the water quality concerns in the SJB. Point sources in the SJB are shown in figure 1.

[Figure 1. Point sources in SJB – from Kratzer and Shelton, 1998]

We present our conceptual model in terms of a schematic diagram of the lower SJR and the central Sierran rivers (Mokelumne and Cosumnes) (fig. 2). The width of the arrows (inputs) in the conceptual model will indicate our best professional judgment about which sources are most significant for various aspects of water quality.

[Figure 2. Conceptual schematic model of SJB]

4. Monitoring Plan Elements

The proposed monitoring plan is presented in tables 2 and 3. Table 2 presents existing and proposed monitoring for continuous data, field parameters, major ions, sediment, and system productivity. Table 3 presents existing and proposed monitoring for constituents of concern for drinking water, trace elements, contaminants, and toxicity. The monitoring sites (existing and proposed) are presented in figure 3 for all categories of constituents. Sites are also shown as either high, medium, or low priority for inclusion in the monitoring plan. The plan addresses the questions of why to monitor, what to monitor, where to monitor, and when to monitor. It also addresses the costs of monitoring. It does not address the questions of who should monitor or how to monitor.

[Table 2. CMARP existing and proposed monitoring plan for water quality in the San Joaquin Basin: Continuous Data, Field Parameters, Major Ions, Sediment, and System Productivity]

[Table 3. CMARP existing and proposed monitoring plan for water quality in the San Joaquin Basin: Drinking Water, Trace Elements, Contaminants, and Toxicity]

[Figure 3. CMARP existing and proposed monitoring sites]

The sites identified in this first draft monitoring plan represent the most important sites based on our present knowledge. However, it is recognized that we do not know all sources of all constituents and in some cases may be overlooking significant sources. To address this issue of spatial coverage, we propose to have some sites be "rotational sites". These sites would be sampled for two years and their significance would be evaluated. Highly significant sites would become part of the regular monitoring program while sites with lesser significance would be dropped. The next two years some additional sites would be added as rotational sites. This process would help to fine tune the monitoring plan. All regular sites would also be re-evaluated on a regular basis. Rotational sites are not included in this draft plan. An example of a candidate rotational site would be Newman Wasteway for dormant spray pesticides. This site was identified as significant by DPR, but this was not confirmed by USGS transport studies.

The rationale behind the proposed monitoring will be discussed here by geographic/program area and by constituent type.

4.1 Geographic/Program area

The geographic/program areas considered in the monitoring plan include imports to the SJB, perennial SJR sites (including major tributaries except for Mud and Salt sloughs), Grasslands area, and the central Sierran river sites.

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4.1.1 Imports to SJB sites

The import to the SJB at the Tracy pumps is a high priority site for monitoring because this imports salinity and other constituents into the SJB through application on agricultural lands along the west-side of the SJR. Monitoring the quality of the DMC at an intermediate point (at O'Neill Forebay) and its endpoint at the Mendota Pool are considered of medium priority. The quality at these sites is impacted by some inputs from drainage sumps along the way from the Tracy pumps to the Mendota Pool. However, the data on these impacts is not as critical as data on the quality at the pumps.

4.1.2 Perennial SJR sites

The SJR sites are grouped into high, medium, and low priority based on magnitude of flows and water quality impacts. High priority sites include the major east-side tributaries (Merced, Tuolumne, and Stanislaus) at their most downstream sites. These sites account for flows and constituent inputs to the SJR. Other sites look at major sources of sediment and OC pesticides (Hospital, Ingram, and Orestimba creeks), ammonia from POTWs (TID 5), dormant spray pesticides (Highline Canal, Orestimba Creek, Merced River, Tuolumne River), and sites necessary to account for selenium loads in the SJR coming from the Grasslands area. These sites include the SJR near Crows Landing (regulatory compliance site), SJR upstream of Merced River (before dilution), and SJR at Fremont Ford (between Salt and Mud sloughs). The SJR at Lander Avenue site is a background site for the lower SJR. It provides information on water quality in the SJR before the Grasslands area inputs, plus it provides information on inputs from Bear Creek and the upper SJB and the Tulare Basin inputs during high flows.

Medium priority sites include sites to evaluate water quality impacts of urban runoff (Dry Creek sites), sediment and OC pesticides (Del Puerto Creek and Spanish Grant Drain), and dormant spray pesticides (Del Puerto Creek, Spanish Grant Drain, Livingston Canal). The Orestimba Creek above I-5 site is a background site for OC pesticides, above the historical application area. These sites are considered a lower priority because they are either lesser inputs or are problems deemed to be of lesser significance in the SJB (e.g., urban runoff).

Low priority sites include reference sites on the major east-side tributaries and an additional load accounting site on the mainstem SJR. The reference sites are generally above the area of agricultural or urban land uses and impacts. These sites represent water quality just below the reservoirs as streams enter the SJV.

4.1.3 Grasslands sites

The Grasslands sites are grouped into high or medium priority based on whether they represent water quality at downstream locations just prior to discharging to the SJR or whether they are more upstream. The downstream, high priority sites include the

beginning and endpoints on the SLD, Mud Slough upstream and downstream of the SLD, and Salt Slough. The more upstream, medium priority sites include several drains which have been monitored by DWR since the mid-1970s, upstream sites in the Grasslands Bypass Project (GBP), Salt Slough near Wolfsen Road, and Panoche Creek. The drains and GBP sites are monitored to evaluate trends in selenium, salinity, and boron from individual sources. The Salt Slough site, coupled with the downstream site, allows an evaluation of the impact of wetlands on water quality. The Panoche Creek site contributes selenium and other constituents to the GBP during periods of high rainfall runoff and also contributes large amounts of sediment locally which is the topic of a CALFED project.

4.1.4 Central Sierran river sites

The main inflows to the Delta from the central Sierra basin is from the Mokelumne and Cosumnes rivers. The Calaveras River is mainly diverted upstream and contributes little flow to the Delta. Therefore, the high priority sites in this area are the Mokelumne River below Camanche Reservoir and the Cosumnes River at two sites. The Mokelumne site provides data on water quality from a major tributary and also the impact of acid mine drainage from Penn Mine. The Cosumnes River is the last remaining large river in the Sierra without a large reservoir. The Nature Conservancy owns a good-sized portion of riparian land along the Cosumnes between the two sites and has been involved in bioassessments and evaluations of flood control alternatives.

4.1.5 Revisiting site selections

These sites have been selected based on information from past studies in the SJB. As new studies are implemented and define different sites of significance in the area, the monitoring network will be re-evaluated. Also, rotational sites will be added to this network (see Section 4).

4.2 Constituent type

The types of constituents considered in this monitoring plan include the following categories: continuous data, field parameters, major ions, sediment, system productivity, drinking water, trace elements, contaminants, and toxicity tests.

4.2.1 Continuous data

Some measure of streamflow is essential to understanding the significance of collected water quality data. This can be achieved by either having a continuous streamflow gage or by making a streamflow measurement at the time of sampling. A gage is preferred since it provides a hydrologic perspective for the streamflow at the time of the discrete sample collection. The present network of streamflow gages in the watershed of the Delta includes about 250 gages; about 100 of these are in the SJB (fig. 4; this figure shows all 250 active gages in the watershed). Some of the proposed and existing sites shown in figure 3 do not have streamflow gages. At these sites, flow measurements are made at

time of sample collection. At sites with significant streamflow and needs for load calculations a gage is proposed. Also, continuous temperature and/or EC is desirable at several sites to evaluate water quality for fisheries or for general water quality purposes.

[Figure 4. Gaging stations in the Delta watershed]

4.2.2 Field parameters

Water quality parameters determined in the field are useful as general indicators of water quality. These parameters include temperature, EC, pH, DO, and alkalinity. Temperature and pH are often critical in determining the speciation of other constituents in the water column at the time of sampling. EC is often related to other constituents and can be used as a surrogate for water quality.

4.2.3 Major ions

The mix of major ions can provide information on sources of water and changes over time. Different sources of water have different signatures based on their mix of major ions. For example, in comparing waters from the Coast Ranges with waters from the Sierra Nevada, waters from the Coast Ranges generally have higher proportions of monovalent cations (Na, K) than divalent cations (Ca, Mg) and higher proportions of sulfate plus chloride than carbonate plus bicarbonate. Thus, it is recommended to collect samples for major ions at most water quality sites at least on a quarterly basis.

4.2.4 Sediment

Suspended sediment is of concern for two reasons: it can physically cause problems for fish by smothering spawning gravels, and it can transport several hydrophobic constituents (such as, OC pesticides and total phosphorus). Sediment transport and deposition is also essential to productivity in certain areas. Thus, it is important to evaluate the transport of suspended sediment and the deposition of bed sediment. Our conceptual model of sediment sources in the SJB is shown in figure 5A. Existing and proposed monitoring sites for sediment are shown in figure 5B. [Discuss Bruce T's issue paper on sediment]

[Figure 5A. Conceptual model of sediment sources in SJB]

[Figure 5B. Existing and proposed monitoring sites for sediment (map)]

4.2.5 System productivity

System productivity concerns include essential plant nutrients (the most common limiting nutrients are N and P) and bioassessments. Our conceptual model of nutrient sources in the SJB is shown in figure 6A. Bioassessments include sampling plants, invertebrates, and fish. By collecting both water column (nutrients) and biological data we get a better idea of the health of the aquatic resource. Existing and proposed monitoring sites for nutrients and bioassessments are shown in figure 6B.

[Figure 6A. Conceptual model of nutrient sources in the SJB]

[Figure 6B. Existing and proposed monitoring sites for nutrients and bioassessments (map)]

4.2.6 Drinking water

Constituents of concern for drinking water uses of waters in the SJB and Delta include THMFP constituents and pathogens. The most common THMFP constituents are TOC and bromides and common pathogens are *Giardia* and *Cryptosporidium*.

4.2.7 Trace elements

Trace elements are generally naturally occurring in the SJB and are essential micronutrients in small doses but can be lethal to aquatic life or agricultural crops in larger doses. The main trace elements of concern in the SJB are selenium, boron, and molybdenum. Our conceptual model of selenium sources in the SJB is shown in figure 7A. Existing and proposed monitoring sites for trace elements are shown in figure 7B.

[Figure 7A. Conceptual model of selenium sources in the SJB]

[Figure 7B. Existing and proposed monitoring sites for trace elements (map)]

4.2.8 Contaminants

Contaminants is a large category which is subdivided in table 3 into metals, dissolved pesticides, suspended pesticides, and VOCs.

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4.2.8.1 Metals

Metals are more of a concern in the Sacramento Basin with the large number of abandoned mines, but there are a few in the SJB. Metals of concern include mercury, cadmium, chromium, copper, and zinc.

4.2.8.2 Dissolved pesticides

Pesticides which are primarily found dissolved in the water column (hydrophilic) are found in the SJR and tributaries at several times throughout the year, but especially during January through August. The biggest documented problem has been with dormant spray pesticides, especially diazinon and chlorpyrifos. The Contaminants PWT suggested a procedure for prioritizing dissolved pesticides for inclusion in a monitoring program. This procedure includes the following steps: (1) generate an initial list of pesticides based on analysis of the DPR Pesticide Use Database, paying special attention to the amount of pesticides applied, the timing and method of application, and the location of application, (2) perform a literature review of transport, fate, and toxicity information for the pesticides applied in the SJB, (3) for pesticides lacking adequate toxicity data, perform acute and chronic toxicity tests on appropriate species to generate the necessary information for ranking the relative toxicity of pesticides, and (4) evaluate existing monitoring data to assess occurrence and concentrations of pesticides in the SJB.

The final product of this four-part assessment will be a ranked list of priority pesticides for monitoring in the SJB. This list will need to be re-evaluated and updated frequently as new monitoring data and toxicity testing data is made available, and as pesticide use changes. Also, analytical methods with ecologically-relevant detection levels will need to be developed for several pesticides.

Our conceptual model of sources of dormant spray pesticides in the SJB is shown in figure 8A. Existing and proposed monitoring sites for dissolved pesticides are shown in figure 8B.

[Figure 8A. Conceptual model of sources of dormant spray pesticides in SJB]

[Figure 8B. Existing and proposed monitoring sites for dissolved pesticides (map)]

4.2.8.3 Suspended pesticides

Some pesticides which are primarily attached to suspended sediment (hydrophobic) are present at levels of concern in the SJB. These include several OC pesticides which have been banned for many years including DDT, toxaphene, dieldrin, and chlordane. Other hydrophobic pesticides may be transported at levels of concern, but have not been

identified as yet due to lack of monitoring. Our conceptual model of sources of OC pesticides in the SJB is shown in figure 9A. Existing and proposed monitoring sites for suspended pesticides are shown in figure 9B.

[Figure 9A. Conceptual model of sources of OC pesticides in SJB]

[Figure 9B. Existing and proposed monitoring sites for suspended pesticides (map)]

4.2.8.4 VOCs

The main VOC of concern at present in the SJB is MTBE. This is of potential concern for drinking water uses of waters in the Delta and possibly elsewhere in the SJB (Pardee Reservoir – EBMUD, New Hogan Reservoir – Stockton, New Don Pedro Reservoir – Modesto). Other VOCs could also be of concern, but have not yet been identified.

4.2.9 Toxicity tests

The DPR does acute and chronic toxicity tests in conjunction with their pesticide monitoring program at Vernalis and Orestimba Creek. This allows them to evaluate whether samples which are toxic have relatively high concentrations of certain pesticides and to evaluate the mix of pesticides during times of toxicity and during times of no toxicity.

4.2.10 Revisiting constituent selections

As new information becomes available, the list of constituents will need to be revisited just like the list of sampling sites. This process was discussed for dissolved pesticides above.

4.3 Costs of monitoring

The costs of monitoring is estimated here for the existing monitoring being done by the various agencies contacted by CMARP and for a proposed monitoring network using average costs from the various agencies involved.

4.3.1 Existing monitoring

[insert cost estimate for existing monitoring]

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4.3.2 Proposed monitoring

[insert cost estimates for high, medium, and low priority monitoring networks]

5 Research

Several gaps in knowledge were identified during our discussions and in putting together the monitoring plan. These gaps are listed here as research questions. They are arranged by constituent groups. No estimates of costs for studies to address these questions have been made.

5.1 Sediment

- What are the major sources of fine-grained sediment in the SJB and how effective are BMPs in reducing these sources?

5.2 System productivity

- How are biological systems (plants, invertebrates, fish) affected by water column quality?
- Are nutrient inputs from the SJB having negative or positive impacts on downstream beneficial uses in the Delta?
- How successful are bioassessments at describing water quality and how frequent should they be done to determine trends in water quality?

5.3 Drinking water

- Are bromides from the SJB a problem for drinking water taken from the Delta? What are the major sources of bromides in the SJB?
- What are the major sources of pathogens in the SJB and are they impacting drinking water uses in the Delta?
- What are the major sources of TOC in the SJB and are they contributing significantly to the THMFP of Delta waters?

5.4 Trace elements

- Can waters with bioaccumulating substances such as selenium be adequately protected with water column criteria or should tissue-based criteria be developed?
- Are criteria for selenium, boron, and molybdenum adequately protecting beneficial uses in the SJB and in the Delta?
- Are other trace elements (e.g., arsenic) a threat to beneficial uses in the SJB or Delta?

5.5 Contaminants

- Is mercury a problem in the SJB?
- Are metals from abandoned mines in the SJB (e.g., Penn Mine in Mokelumne basin) causing problems for beneficial uses in the SJB or Delta?
- Can diazinon and chlorpyrifos concentrations be reduced to non toxic levels by BMPs that do not rely on the use of alternative pest management strategies?
- How much of the diazinon and chlorpyrifos is being transported by atmospheric sources?
- Are other pesticides in the SJB causing toxicity in the SJB or Delta?
- Are OC pesticides still causing problems in the SJB and Delta and how effective are various BMPs at reducing their transport?
- Is MTBE or other VOCs a problem in the SJB?

5.6 Toxicity tests

- How effective are toxicity tests at describing potential toxicity to resident organisms?
- How useful are toxicity tests for evaluating BMPs or identifying sources of contaminants?
- Are the species used in toxicity tests of significance to the higher trophic levels and community structure in the SJB or Delta?

6 Indicators

The appropriate indicators of water quality in the SJB include the various water column concentrations, biological resources, sediment quality, and streamflow.

7 Links

This group interacted with several other CMARP groups during the preparation of this draft document. These groups include the SJR Salmon, Mokelumne Salmon, Cosumnes Salmon, Calaveras Salmon, Watershed, Water Transfers, and the other Water Quality groups.